A

Some notes on

DEMOGRAPHIC STUDIES RELATED TO PEDIATRIC AND GENETIC PROBLEMS

J. Lederberg

A. Seasonal Variation of Births. General Considerations.

Birthrates follow a marked seasonal rhythm. In 1960[1] the total U.S. population data peaked in September at +11.0% and troughed in May at -7.6% of the average rate for the year. Each segment of the population, classified by state, maternal age, birth order, and color shows characteristic deviations in the fine structure of this cycle, although the timing of the minimum and maximum is not greatly altered. A similar cycle, with characteristic deviations, has also been exhibited in past years. The cycles are notably different in different countries.

The usefulness of this profile for epidemiological studies has been obscured by contentious speculations as to its biological basis. Selected samples of the population have been found to have grossly atypical profiles. It would be a matter of extraordinary interest and importance for human biology to learn whether human performance can be so markedly influenced by the season of birth[2]. However, before this can be rigorously analyzed, we must first learn much more about the statistics of seasonality of births from different cultural samples. Furthermore, whether or not performance is determined by birth-season, the profile can be seen to be a useful signature of a given sample. The very wide availability and relative objectivity of birthdate information compensates for the insensitivity of these data in contrasting samples. This point may be restated: No other datum is so readily available on a uniform, reliable basis, and full advantage should be taken of it in demographic and epidemiological studies.

At the very least, the profile should be demonstrated for control purposes. Stratification of the samples is a vexatious problem in almost every statistical study, e.g. the effect of blood group on gastrointestinal ulcer or cancer, or of smoking on vascular disease. If the experimental samples are comparable, they should not have significant differences in their birthdate-profile; when large numbers are available, similarity of profile would give considerable reassurance of the avoidance of substantial biases, at least with respect to those variables so far found to influence the profile. To develop the full utility of this approach will then require careful study of a range of cultural and genetic determinants. Large scale studies, suitable for such calibration, have been quite limited; much useful information is presumably available in such records as are kept for census, vital statistics, insurance, social security (linked to income tax), educational, military service and other registrations. Unfortunately, family correlations which might be the most useful, are perhaps the least readily available on a large scale.

The National Vital Statistics Division has already published analyses of birth seasonality[3] showing annual changes in the rhythm, and the effects of color and region. The last factor predominates; color has a relatively small effect except in the Northeast. The rhythm is accentuated in the South, shallow in the Western region. All regions except the South show a secondary maximum (February, North Central; March, West and North East (white)).

The published data can also be analyzed for the effect of birth order, no remarkable difference is seen between orders I and II (except the secondary peak is March for order I, U.S. 1960). (This makes a rigorous coupling of the birth rhythm to the marriage rhythm unlikely.) There is, however, a substantial effect of maternal age - mothers over 30 show a shallower cycle and the secondary peak in February-March disappears (perhaps better stated, the secondary minimum in December-January disappears). Compared to total births, children of older mothers will be relatively more numerous in the interval November-February. However, over the whole U.S. the absolute peak remains September. (Only further work can tell whether a stratum can be isolated from this pool with a distinct cycle.) This effect warrants close scrutiny in view of many reports of atypical performance of this birthclass, e.g. admissions to an institution for the mentally retarded[4] as well as unusual intellectual achievement[2].

The interaction of maternal age effect on birth seasonality with the seasonal variation of infantile morbidity cannot be ignored in any studies of maternal age effects.

The effects of prematurity on performance can also be studied through the birthdate distribution. The infant mortality rate (deaths within 28 days relative to live births) peaks sharply in May, whether for total mortality or that in which immaturity is mentioned. The calculation is complicated by the expression for the base, but most of the effect can be attributed to about two months phase lag for immature relative to total births. Further samples dominated by immature births should show a similar accentuation of risk relative to total births in May or at least in the interval before the live birth peak in September (nonwhite: August). Knobloch and Pasamanick's data[4] show only a slight inflection in this interval.

B. Seasonal Variation of Births. Relationship to Mental Performance.

Many studies (reviewed by Barry and Barry[5]) have purported to show a variation in the mental performance of children with the month of year in which they were born. In fact this conclusion, despite its astrological overtones, could have a number of biological and psychological bases of reasonable plausibility - the seasonal variation in epidemic disease, seasonal effects on immunological activity, (Shaw and Stone[6]), the phase relationship of individual development with the school cycle, the psychological impact of other seasonally dependent environmental factors on the newborn child; also as Knobloch and Pasamanick[4] have proposed, possible seasonal variations in prenatal maternal nutrition. It remains to be seen however, whether any of the purported effects are real and if they represent

an effect of the environment on the performance of the child, or a variation in the birth patterns of families of different socio-economic strata which may differ both in genetic composition and in the opportunities for expression and educational development. The later point has been repeatedly raised but few data have been published that could help assess the variation in birth seasonality among economic strata as a necessary preliminary to any biological intrepretation. In fact, Pasamanick, Dinitz and Knobloch[7] have published data indicating considerable interaction between socio-economic stratus and birth season but have unaccountably discounted this variable in their discussion[4] of the influences on mental retardation.

In a study to attempt to corroborate a characteristic distribution of birth season among mentally retarded, a considerable file has been analyzed from the records of the Pacific State Hospital at Pomona, California, through the courtesy of Dr. George Tarjan, with results indicated in Figure 1 attached. The problem arises what to use as a control base for the evaluation of these statistics; they do show a significant departure from the distribution of the average season of birth for the Western U.S. over the same epoch.

C. Reproduction Patterns.

Figure 2 represents a preliminary study on the 1959 Vital Statistics file from the Department of Public Health of the State of California, representing a 10% sample of the births in the state during that year, on which a fuller set of data had been transcribed from the registrations. In particular, it was possible to tabulate the seasonal incidence of birth with respect to the occupational classification of the father. As Figure 2 demonstrates, there is a substantial (and statistically quite significant) discrepancy between the two parts of the sample: The professional, managerial and administrative occupations (census classifications 1 and 2) and the remaining families represented in this sample. This is by no means a complete analysis. The demonstrable difference between these two lumped categories would suggest even deeper differences among the more appropriately chosen strata of the actual population which have been blurred in the pooling process. On the basis of these findings it seems doubtful whether any biological conclusions whatever can be drawn from the statistics of birth incidences until deeper studies have been made of the sociological factors that influence the occurrence of births in different seasons. While birth date statistics are in principle generally available on a very large scale, few tabulations of this kind have been made to date that would contribute to the problem.

D. Seasonal Variations of Births. Some Paradoxes.

Several authors have attempted to relate the seasonal distribution of births to the peaking of marriages in June. However, published tabulations[8] have consistently shown a rather flat distribution of interval from marriage to the birth of first child, peaking if anywhere at about 12 months. This should lead to a definite peak in births, 12 months after

the main marriage peak in June and will not account at all for the peak in September which is actually observed both for births of the first rank and for later parities. In fact one is entitled to predict from this discrepancy that marriages in June are atypical with respect to child-spacing and probably to fertility in general, as compared to marriage in the other months. Social hypotheses that would be consistent with such statistics are self-evident: It would be appropriate to obtain the quantitative information on the relationships between these variables before attempting to construct such hypothesis. If these conclusions are correct however, there is a rich structure of inter-relationships involving origins of the family and expressed in seasonal variations and temporal patterns of reproductive performance. On the one hand these interfere with any simple analysis of the effects of seasonal variation; on the other they may furnish a very useful criterion of equivalence-in-background of any set of sample populations which are to be compared for any other purpose.

Figure 3 shows a tabulation of births in California during 1960 by individual week and gives some indication of the fine structure that can be expected in such statistics. Such distributions, broken down into enough cells to show fine structure, are of course liable to sampling fluctuations which can however be usefully minimized by the further collection of data from other sources and for other years. The source data are given by single day and week in Table 1.

E. Seasonality of Marriage.

While one would suppose that the seasonality of marriage, in particular the composition of the June peak, and marriage during such religious holidays as Lent, would depend very strongly as "socio-economic" factors, and that this in turn would influence seasonal effects on births, very little concrete information is available on this point. Regional and urban geography have been studied in an introductory study[9].

Figure 1

Relative Birthmonth Distributions
(corrected for length of month)

a. Retarded in California Institutions
b. Western States summary

c. Ohio retarded (from Knobloch and Pasamanick) expressed as risk coefficient

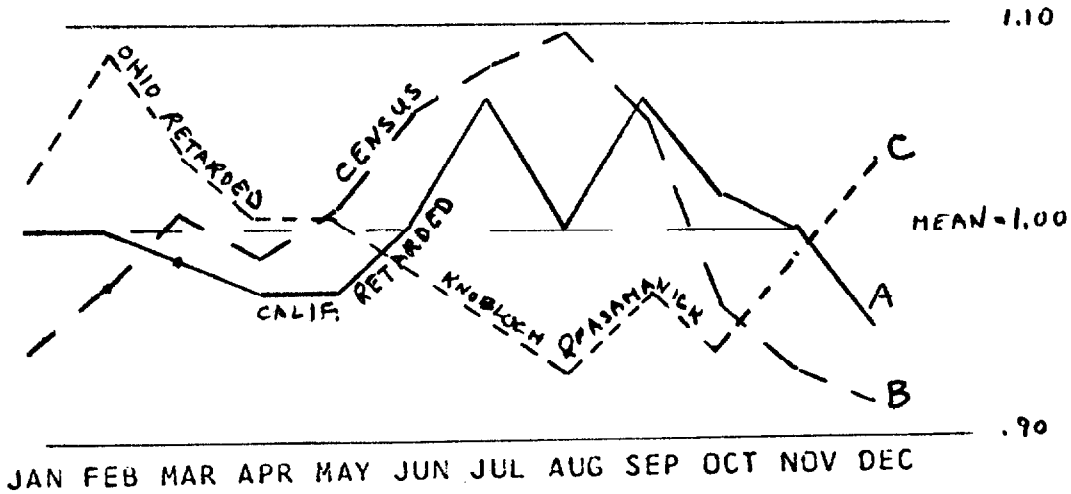
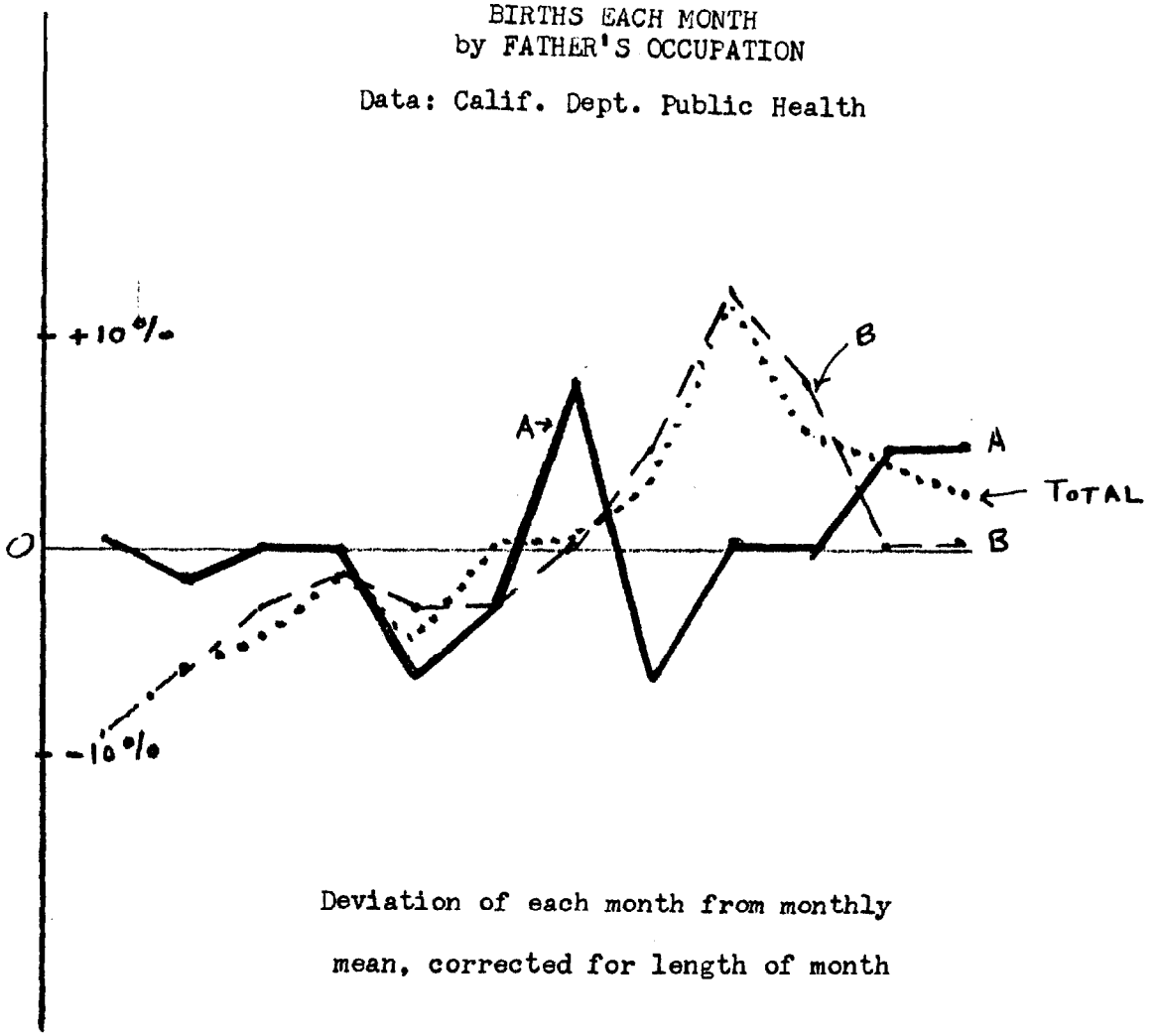


Figure 2

CALIFORNIA 1959 10 pc. sample

BIRTHS EACH MONTH
by FATHER'S OCCUPATION

Data: Calif. Dept. Public Health



Deviation of each month from monthly mean, corrected for length of month

JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

WHITE, ALL BIRTHANKS

Occupational groups from sample	A:	professional, managerial, administrative	6699 births
	B:	remaining categories	24586 births
Total		California Vital Statistics	319940 births

The data were:

a. 566 509 569 545 529 526 617 532 550 571 584 601 6699
b. 1883 1774 2001 1970 2008 1940 2108 2203 2298 2250 2040 2111 24586

A 2x12 contingency test shows highly significant discrepancy: $Xi^2 = 27.13$, $p<.001$

Figure 3

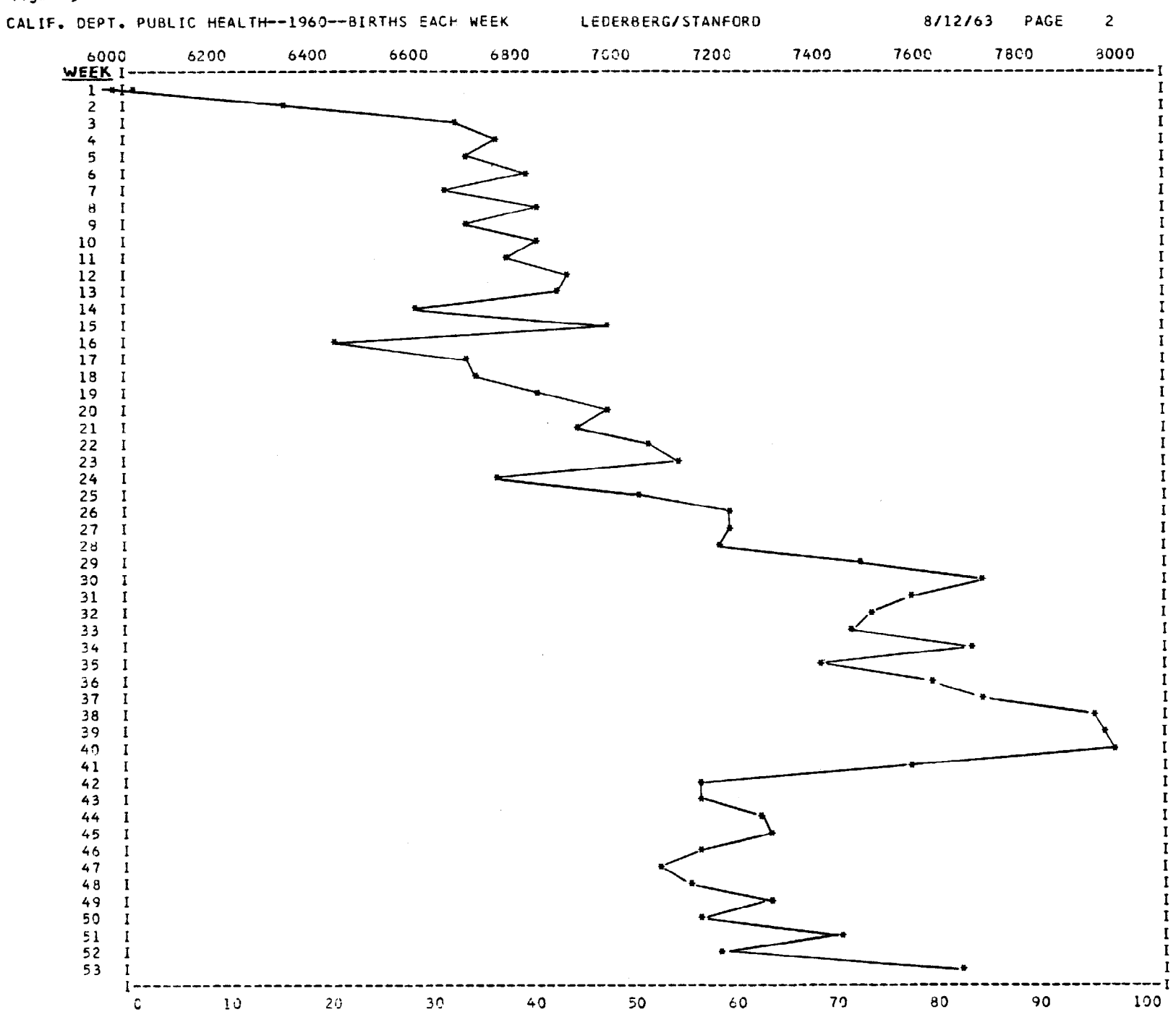

CALIF. DEPT. PUBLIC HEALTH--1960--BIRTHS EACH WEEK LEDERBERG/STANFORD 8/12/63 PAGE 2
6000
6200
6400
6600
6800
7000
7200
7400
7600
7800
8000
WEEK
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
0
10
20
30
40
50
60
70
80
90
100

Figure 3
Source Data

CALIFORNIA 1960 BIRTHS

WEEK AND DAY

WEEK ↓	DAY							
	SUN.	MON.	TUES.	WED.	THURS.	FRI.	SAT.	TOTAL
1	0	0	0	0	0	826	785	1611
2	781	928	948	876	948	931	891	6303
3	835	917	1069	949	953	975	947	6645
4	868	1028	1044	986	945	944	919	6734
5	897	938	987	924	983	1042	894	6665
6	872	984	987	948	981	1014	995	6781
7	916	992	1001	933	930	961	899	6632
8	913	957	1002	996	1041	976	926	6811
9	925	874	983	958	1001	961	970	6672
10	878	970	1076	995	929	1018	953	6819
11	880	955	1033	951	984	992	948	6743
12	892	980	1049	997	950	1014	985	6867
13	886	1006	1066	981	973	1016	924	6852
14	859	889	981	929	893	1005	1005	6561
15	966	1060	1012	1028	960	1001	917	6944
16	838	936	896	995	938	933	874	6410
17	853	930	1053	979	966	936	957	6674
18	844	991	1007	994	920	989	943	6688
19	844	1033	1003	997	948	1009	975	6809
20	879	1004	1039	1059	998	970	992	6941
21	881	969	1081	957	978	1053	975	6894
22	823	1042	1008	1023	1055	1095	984	7030
23	938	903	1039	1110	1045	1125	933	7093
24	876	919	1045	959	954	999	987	6739
25	978	966	1062	1010	1026	1005	971	7018
26	880	1015	1075	1095	1051	1069	1003	7188
27	910	1007	1108	1056	1040	1062	1015	7198
28	930	895	1040	1125	1025	1098	1064	7177
29	936	1024	1123	1069	1098	1159	1049	7458
30	1000	1084	1155	1133	1081	1149	1088	7690
31	1014	1079	1106	1091	1080	1130	1048	7548
32	990	1047	1181	1046	1073	1074	1052	7463
33	973	997	1078	1115	1084	1103	1082	7432
34	990	1120	1149	1128	1101	1197	989	7674
35	983	1018	1093	1022	1078	1108	1073	7375
36	965	1081	1135	1116	1117	1125	1051	7590
37	963	1026	1126	1157	1135	1158	1124	7689
38	1024	1140	1156	1233	1146	1117	1096	7912
39	1025	1136	1150	1160	1166	1219	1072	7928
40	1156	1200	1153	1114	1123	1111	1092	7949
41	967	1170	1166	1079	1091	1103	973	7549
42	899	1060	1035	1030	1034	1057	1012	7127
43	978	991	1111	971	1074	1036	963	7124
44	997	1067	1069	1046	1054	1038	984	7255
45	886	1074	1114	1058	1047	1081	1000	7260
46	899	1061	1034	947	1015	1098	1072	7126
47	913	1020	1022	1039	1048	1052	951	7045
48	906	1101	1091	1028	893	1041	1043	7103
49	954	1060	1048	1079	1101	1077	947	7266
50	976	1022	1031	1020	1022	1055	1013	7139
51	950	1105	1094	1065	1045	1143	1011	7413
52	905	1056	1139	1094	1025	1023	924	7166
53	860	885	1096	1231	1181	1241	1149	7643
	47951	52712	55349	53881	53327	55714	52489	371423
Average	940.2	1033.6	1085.3	1056.5	1045.6	1071.4	1009.4	
Discrepancy Ratio	.909	.999	1.049	1.021	1.011	1.036	.976	

References

1. Vital Statistics of the U.S. 1960 (Dept. H.E.W.)

2. Huntington, E. (1938). The Season of Birth. Wiley, N.Y.

3. Waggoner, D. E. and Schachter, J. (1959). Seasonal Variations of Births in the United States, 1948-54. Vital Statistics - Special Reports, 47(4):129:143. Shapiro, S. and Halpin, E.H. (1947) Seasonal Variation in the Crude Birth Rate. Vital Statistics - Special Reports. 23(17):329:335.

4. Knobloch, H. and Pasamanick, B. (1958). Seasonal Variation in the Births of the Mentally Deficient. Am. J. Publ. Health 48 (9): 1201-1208.

5. Barry, Herbert (III) and Barry, Herbert (Jr.). (1961). Season of Birth. Arch. Gen. Psychiat. 5:100-108. Lewinski, R. J. (1954) Variations in Mental Ability According to Month, Season, and Period of Birth. J. Gen. Psychol. 85:281-288.

6. Shaw, D. H., and Stone, W. H. (1958). "Seasonal" Variation of Naturally Occurring Iso-Antibodies of Man. Trans. G. Int. Congress Hematology. S724-732.

7. Pasamanick, B., Dinitz, S., Knobloch, H. (1960). Socio-Economic and Seasonal Variations in Birth Rates. Milbank Memorial Fund Quarterly. 3:248-254.

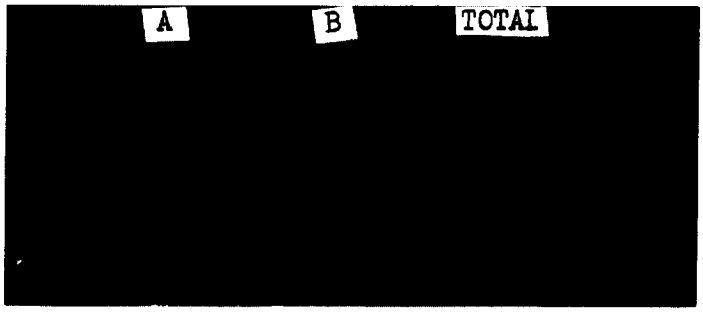
8. Grabill, W. H. and Parke, R. (1961). Marriage, Fertility, and Childspacing: August, 1959. Bureau of the Census, Current Population Reports P20(108) 1:55. References to other work are given by Schachter, J. (1958). Child Spacing as Measured From Data Enumerated in the Current Population Survey: U.S. April 1950 to April 1954. U.S. Vital Statistics - Special Reports, 47(3)75:126, which also includes census tabulations on child spacing (in annual intervals only, but cross-tabulated on several variables).

9. Carter, H. and Sutton, G. F. (1959). Bevolkerungskongreβ, Wien:161:172. Union internationale pour l'étude scientifique de la population.

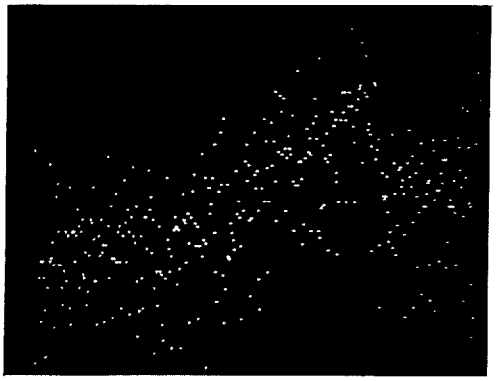
During the few days the accompanying material was being duplicated, the LINC computer was installed in our department, and several display programs have been written (by Mr. Lee Hundley and myself), and tested on the data of the accompanying figures. Photographs hardly do justice to the sense of dynamic intuition that the graphic display of such data can afford, even with just doing the primitive operations of scaling ordinates and other simple arithmetic <u>in real time</u>.

LINC - OSCILLOSCOPE DISPLAYS OF STATISTICAL SUMMARIES

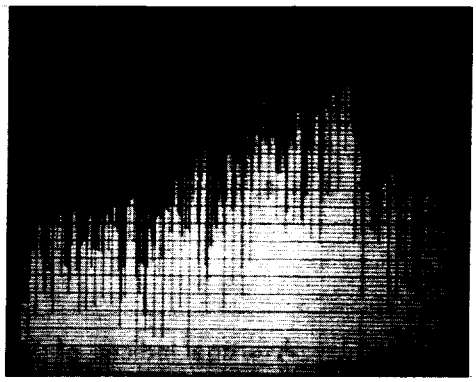
Birthmonth distributions by father's occupation. (Data of Figure 2).



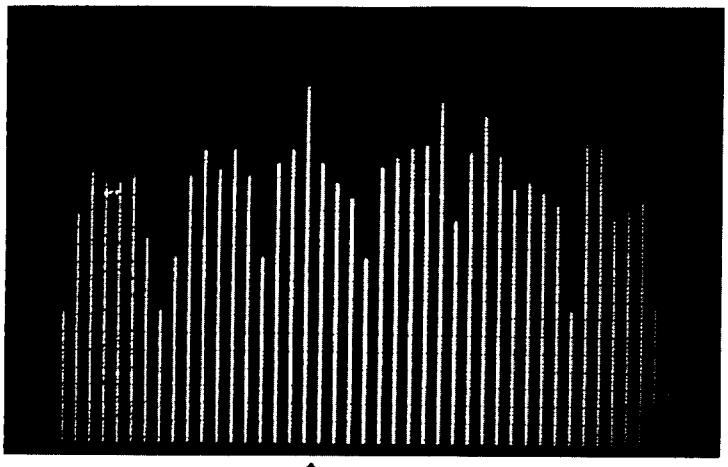
California 1960 births by single day. (Figure 3). The point display (a) is uninterpretable. The bargraph display (b) can be interpreeted, but significant features are better observed in (c), a magnified window showing the weekly cycle, and (d), an integration showing sums by week (=Fig. 3).



(a)

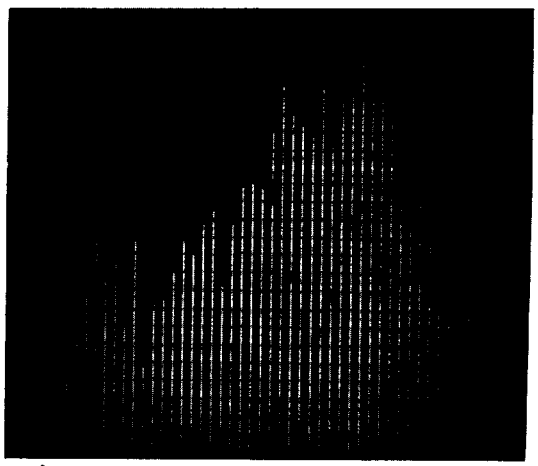


(b)



(c)

↑
Sept. 23



(d)

↑
Sept.; week 40

Waggoner,D.E. and Schacnter,J. (1959)
Seasonal variations of births in the
U.S.,1948-54. Vital Statistics, Special
Reports, 47(4):127-143.

Figure 1

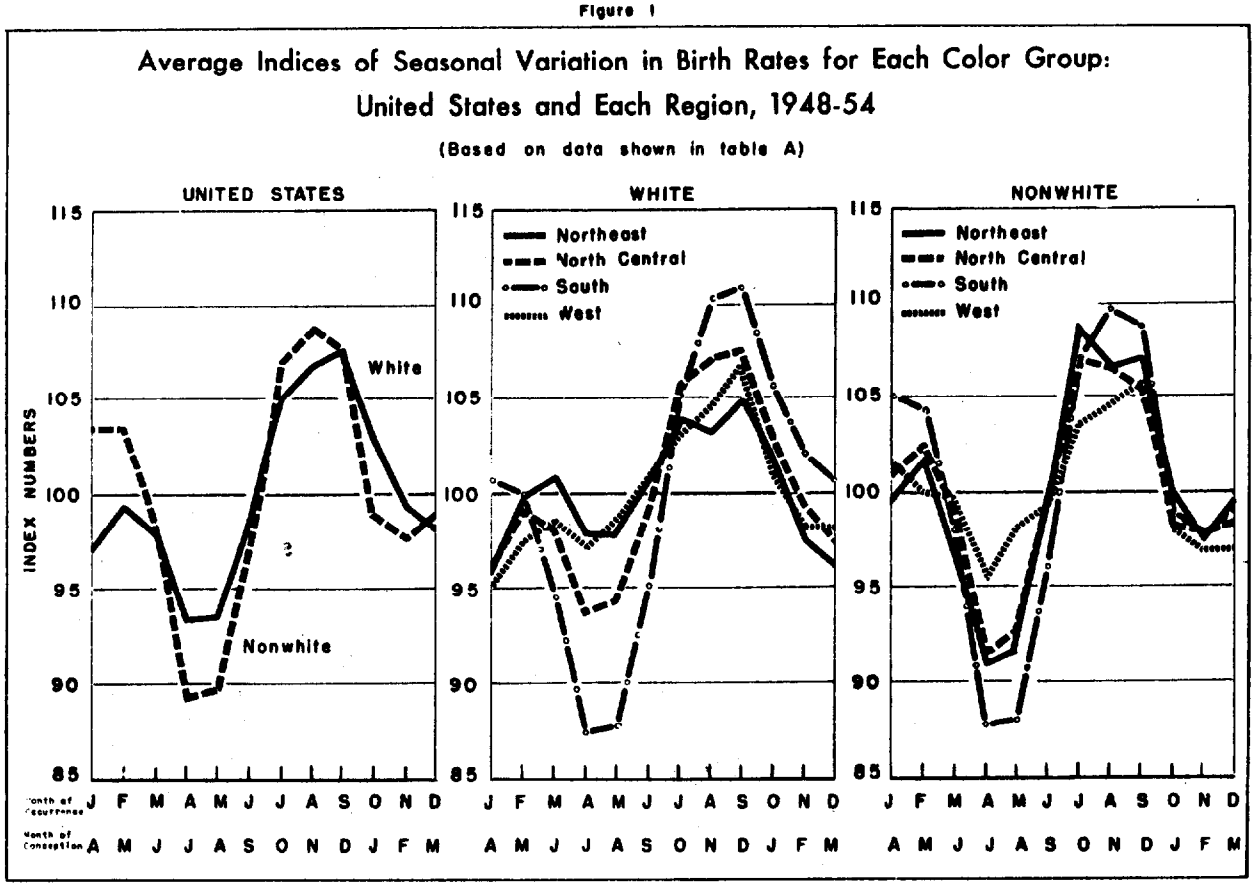


Figure 2